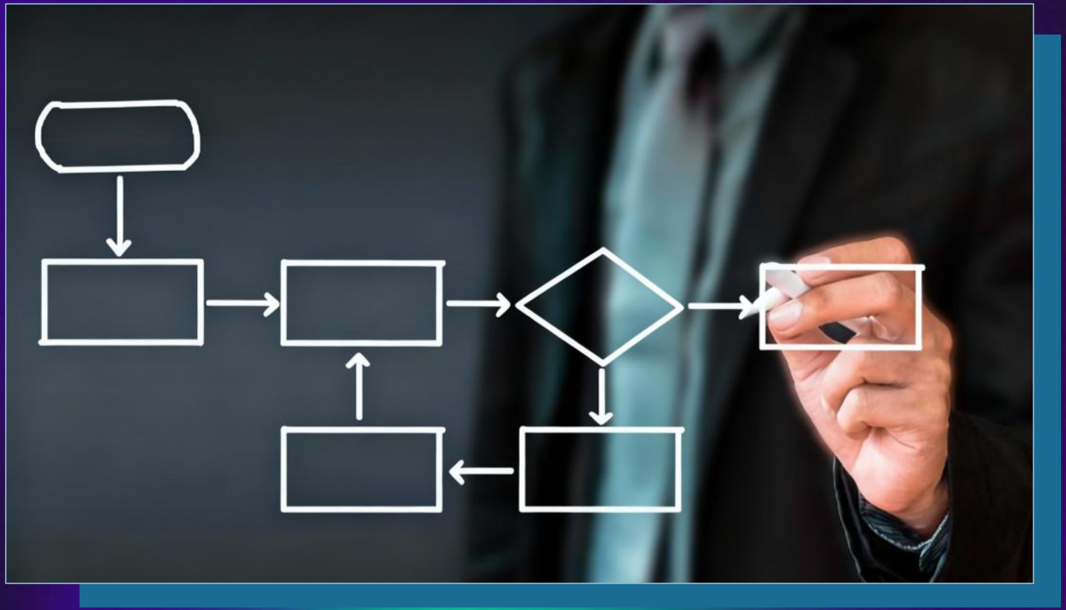
Control-Flow Logic – Part 2

Conditions, If-Else, Switch-Case, Code Blocks, Loops (for, while, do-while), Nested Loops



Svetlin Nakov, PhD

Co-founder @ SoftUni

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Agenda

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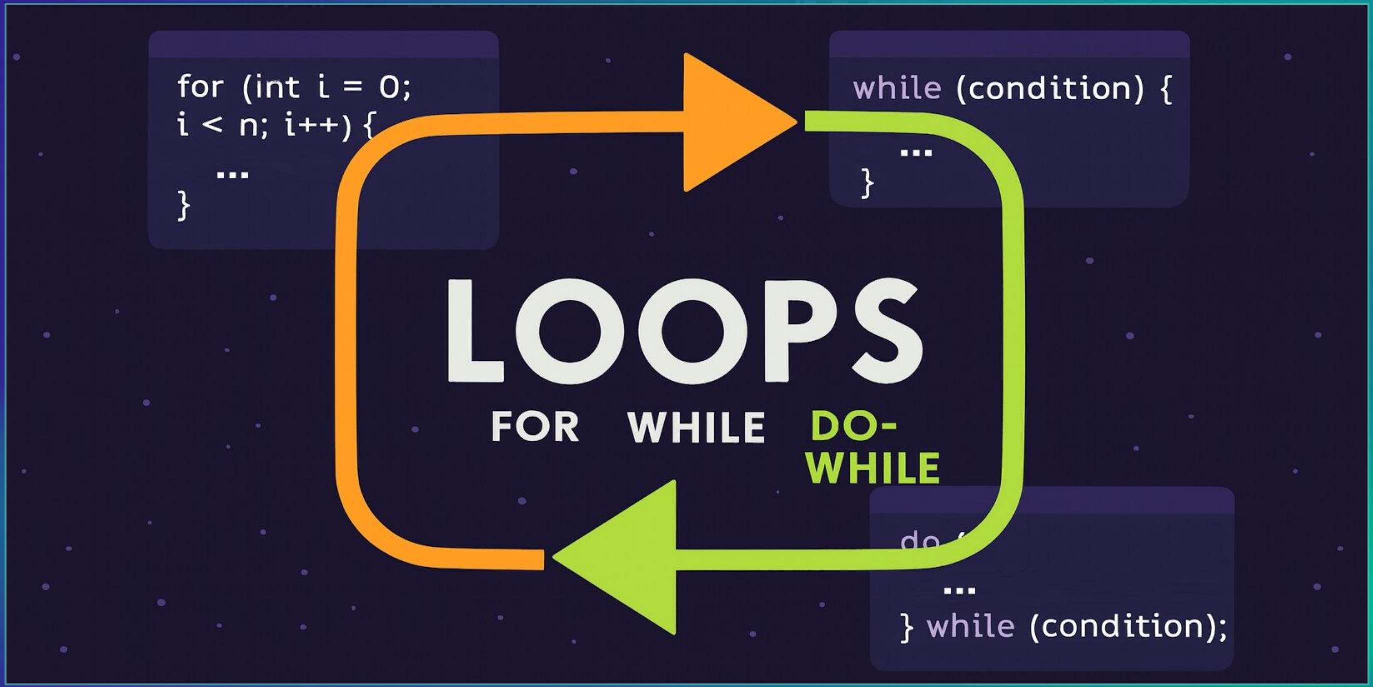
Loops: Running a Block of Code Multiple Times

for-loop, while-loop, do-while-loop



```
for (int i = 0;
i < n; i++) {
    ...
}
```

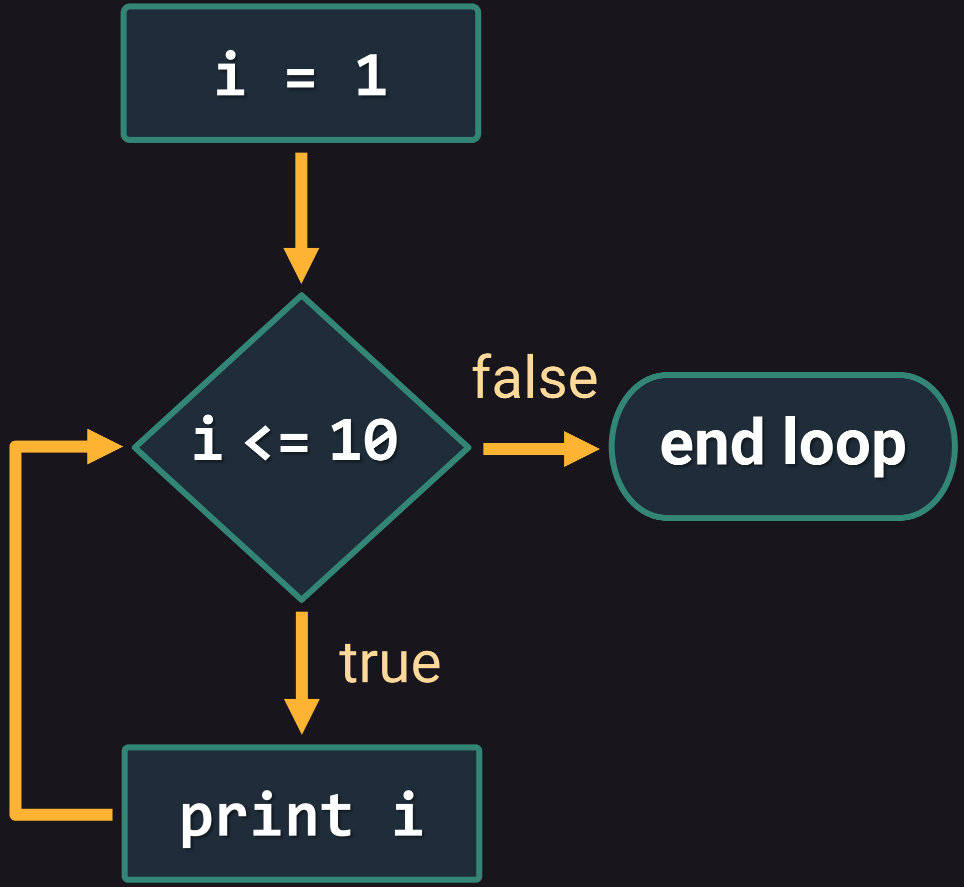
```
while (condition) {
    ...
}
```

```
do {
    ...
} while (condition);
```

What is a "Loop"?

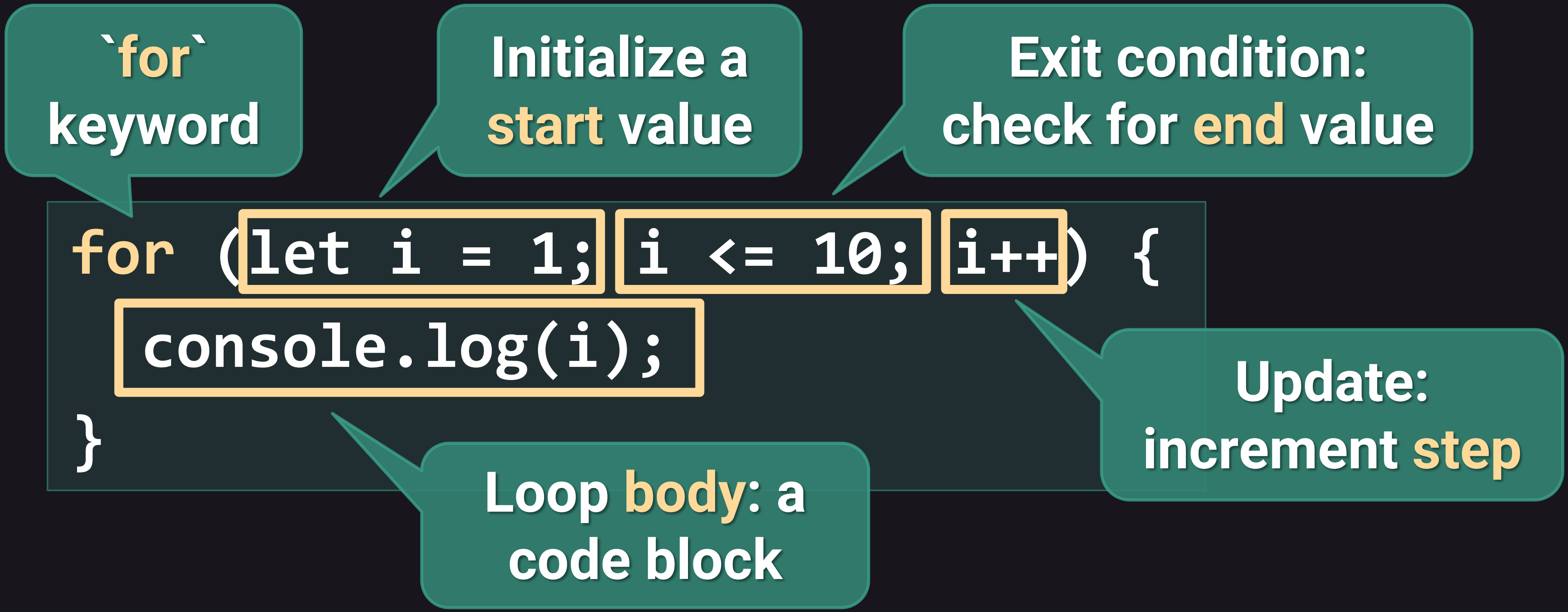
- In coding, **loops repeat a block of code** multiple times
  - **Fixed** number of times, e. g. 10
  - Until an **exit condition** happens
- Example:
  - Print the **numbers 1, 2, …, 10**:

```
for (let i = 1; i <= 10; i++) {
  console.log(i);
}
```



For-Loop Statement

- **For-loops** repeat a block of code from **start** to **end** value



```
for (let i = 1; i <= 10; i++) {
  console.log(i);
}
```

Numbers 1…100 and Their Sum

- Write a JavaScript function to print the **numbers 1…100**, along with **their cumulative sums**
  - Expected output:

```
num = 1, sum = 1
num = 2, sum = 3
num = 3, sum = 6
…
num = 99, sum = 4950
num = 100, sum = 5050
```

  - Sample **solution**:

```
let sum = 0;
for (let i = 1; i <= 100; i++) {
  sum += i;
  console.log(
    `num = ${i}, sum = ${sum}`);
}
```

Problem: Numbers and Sums

- Write a JavaScript function **printNumsSums(n)** to print the **numbers 1…n**, along with **their cumulative sums**
  - Output for **n** = **6**:

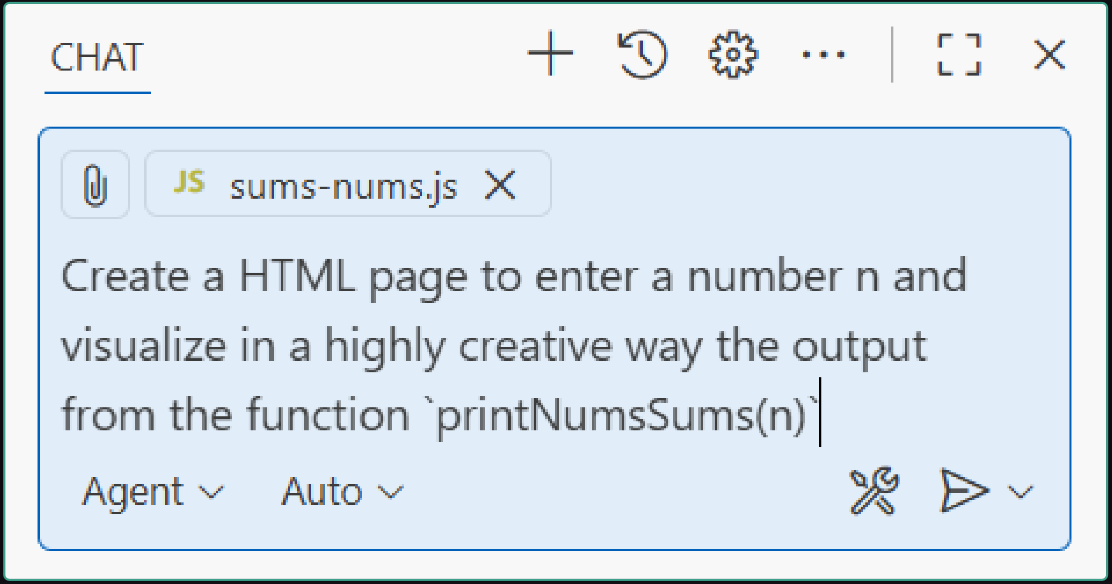
```
num = 1, sum = 1
num = 2, sum = 3
num = 3, sum = 6
num = 4, sum = 10
num = 5, sum = 15
num = 6, sum = 21
```

```javascript
function printNumsSums(n) {
  let sum = 0;
  for (let i = 1; i <= n; i++) {
    sum += i;
    console.log(
      `num = ${i}, sum = ${sum}`);
  }
}
```

Judge link: https://alpha.judge.softuni.org/contests/control-flow-logic/5271

Creative a Visualization of Sums

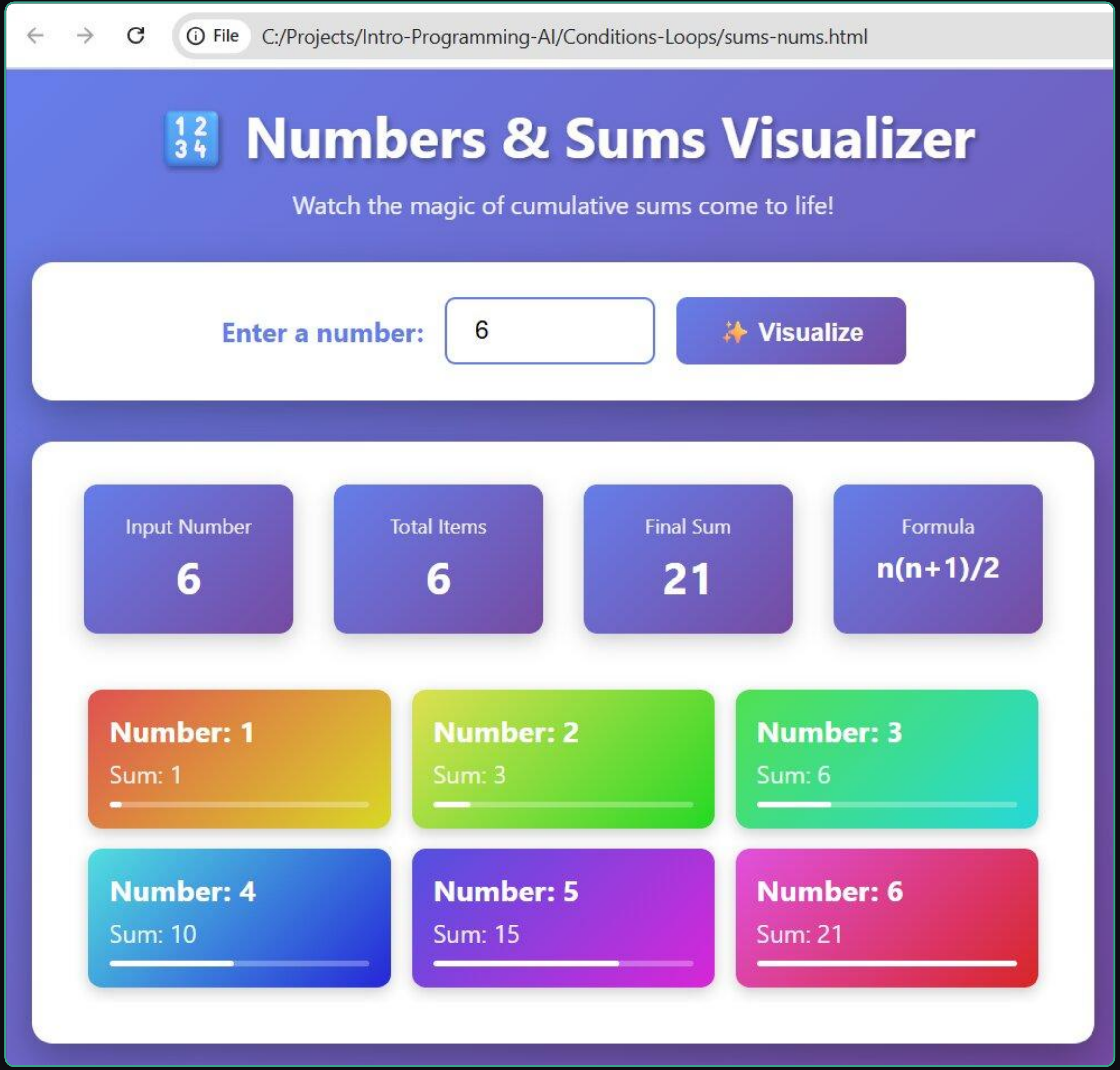
Create a HTML page to enter a number n and visualize in a highly creative way the output from the function `printNumsSums(n)`.


CHAT

sums-nums.js

Create a HTML page to enter a number n and visualize in a highly creative way the output from the function `printNumsSums(n)`

Agent Auto


C:/Projects/Intro-Programming-AI/Conditions-Loops/sums-nums.html

Numbers & Sums Visualizer

Watch the magic of cumulative sums come to life!

Enter a number: 6 ✨ Visualize

Input Number 6

Total Items 6

Final Sum 21

Formula n(n+1)/2

Number: 1 Sum: 1

Number: 2 Sum: 3

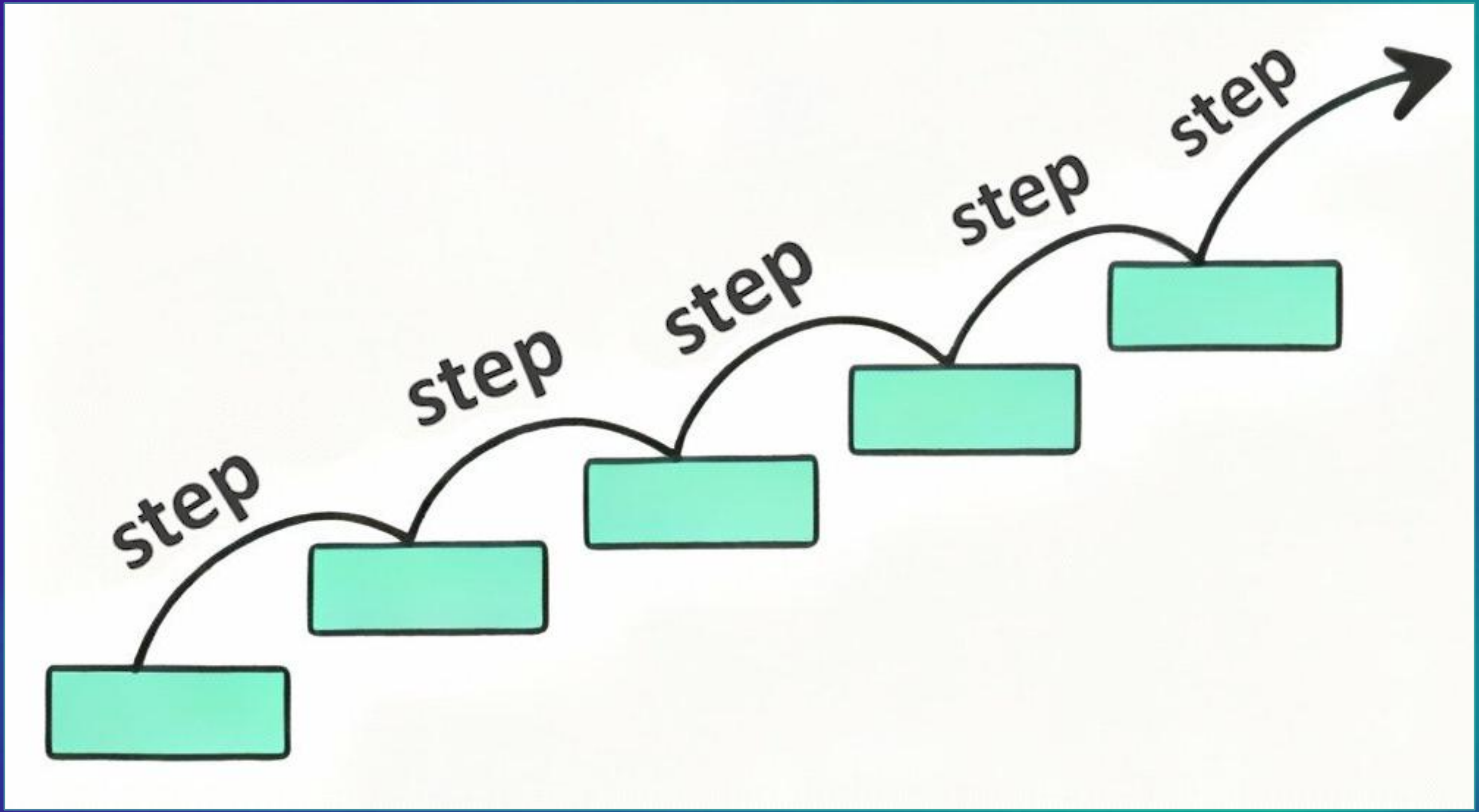
Number: 3 Sum: 6

Number: 4 Sum: 10

Number: 5 Sum: 15

Number: 6 Sum: 21

Loops with a Step



Loops with a Step

- **Backwards iteration** loop: print numbers 20, 19, …, 1

```
for (let i = 20; i >= 1; i--)
  console.log(i);
```

- Loop with a **step +2**: print numbers 100, 102, 104, …, 200

```
for (let i = 100; i <= 200; i += 2)
  console.log(i);
```

- Loop with a **step /2**: print numbers 1024, 512, 256, …, 1

```
for (let i = 1024; i >= 1; i /= 2)
  console.log(i);
```

Problem: Color Gradient Loop

- Write a function to calculate a **color gradient**: from **black** {**0**, **0**, **0**} to given **RGB color** {**red**, **green**, **blue**} in **n** steps

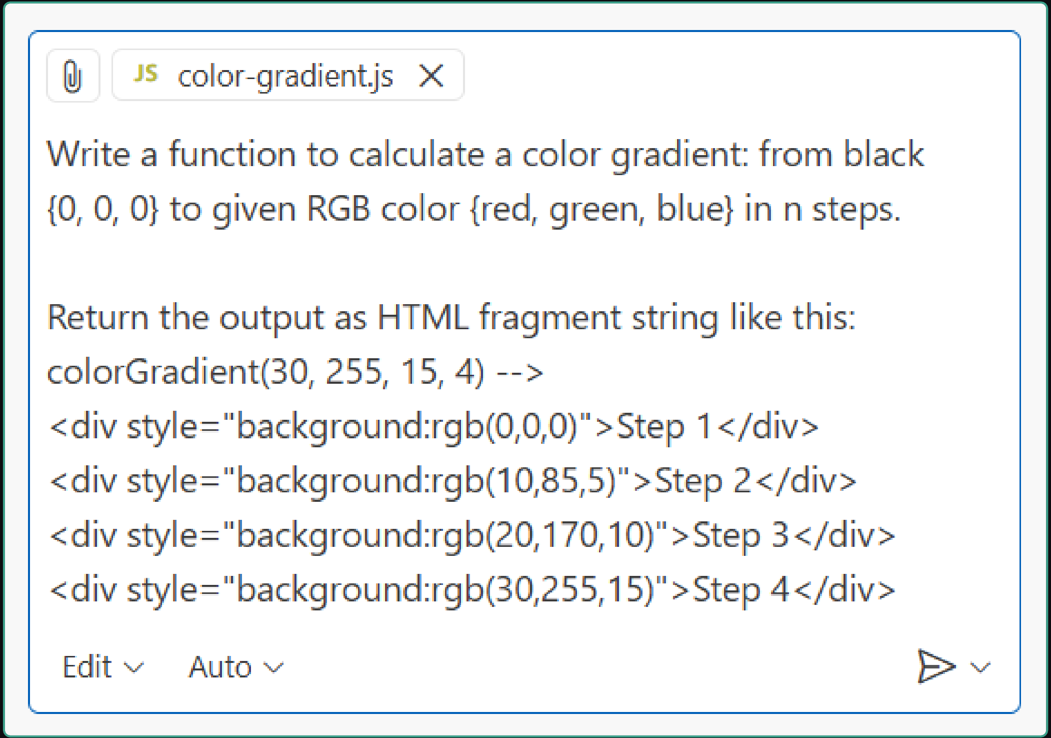
```
function colorGradient(red, green, blue, steps) { … }
```

- Return the output as **HTML fragment** string like this:

```
colorGradient(30, 255, 15, 4)
```

```
<div style="background:rgb(0,0,0)">Step 1</div>
<div style="background:rgb(10,85,5)">Step 2</div>
<div style="background:rgb(20,170,10)">Step 3</div>
<div style="background:rgb(30,255,15)">Step 4</div>
```

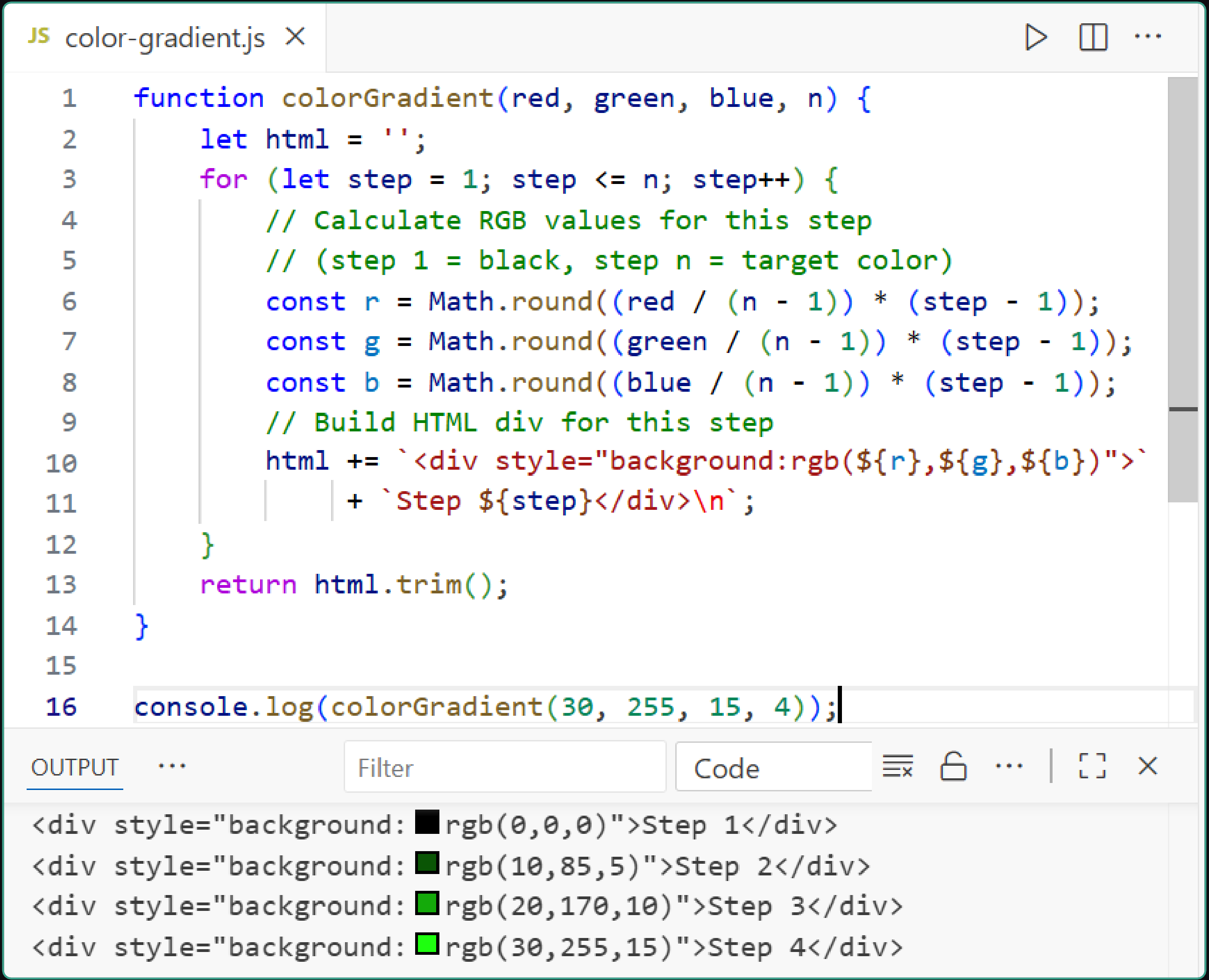
Solution: Color Gradient Loop



color-gradient.js

Write a function to calculate a color gradient: from black {0, 0, 0} to given RGB color {red, green, blue} in n steps.

Return the output as HTML fragment string like this:
colorGradient(30, 255, 15, 4) -->
<div style="background:rgb(0,0,0)">Step 1</div>
<div style="background:rgb(10,85,5)">Step 2</div>
<div style="background:rgb(20,170,10)">Step 3</div>
<div style="background:rgb(30,255,15)">Step 4</div>



color-gradient.js

```javascript
function colorGradient(red, green, blue, n) {
    let html = '';
    for (let step = 1; step <= n; step++) {
        // Calculate RGB values for this step
        // (step 1 = black, step n = target color)
        const r = Math.round((red / (n - 1)) * (step - 1));
        const g = Math.round((green / (n - 1)) * (step - 1));
        const b = Math.round((blue / (n - 1)) * (step - 1));
        // Build HTML div for this step
        html += `<div style="background:rgb(${r},${g},${b})">`
            + `Step ${step}</div>\n`;
    }
    return html.trim();
}

console.log(colorGradient(30, 255, 15, 4));
```

```
<div style="background:■rgb(0,0,0)">Step 1</div>
<div style="background:■rgb(10,85,5)">Step 2</div>
<div style="background:■rgb(20,170,10)">Step 3</div>
<div style="background:■rgb(30,255,15)">Step 4</div>
```

Judge link:
https://alpha.judge.softuni.org/contests/control-flow-logic/5271

Learn to Read and Understand Code!

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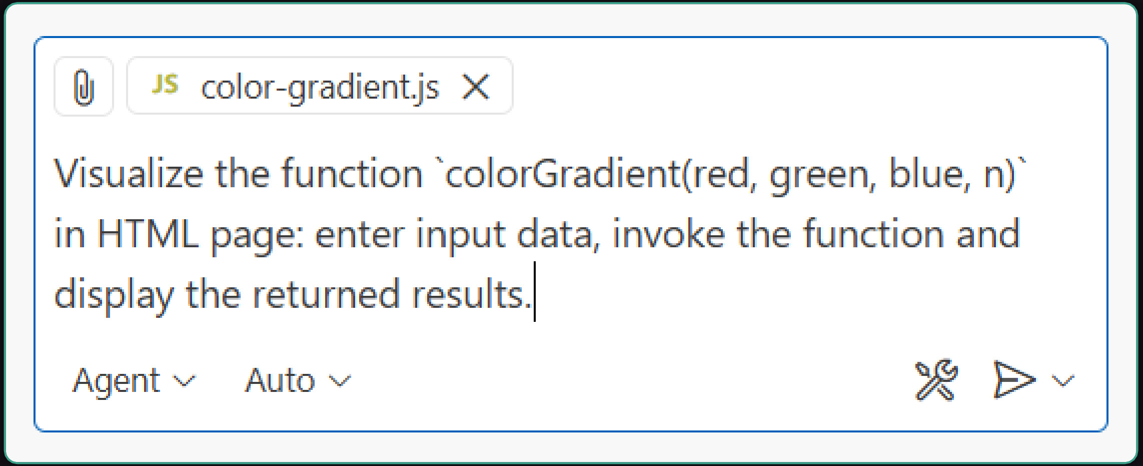
- The code for "color gradient" is not easy for beginners

Learn to read and understand the code, not to write it!

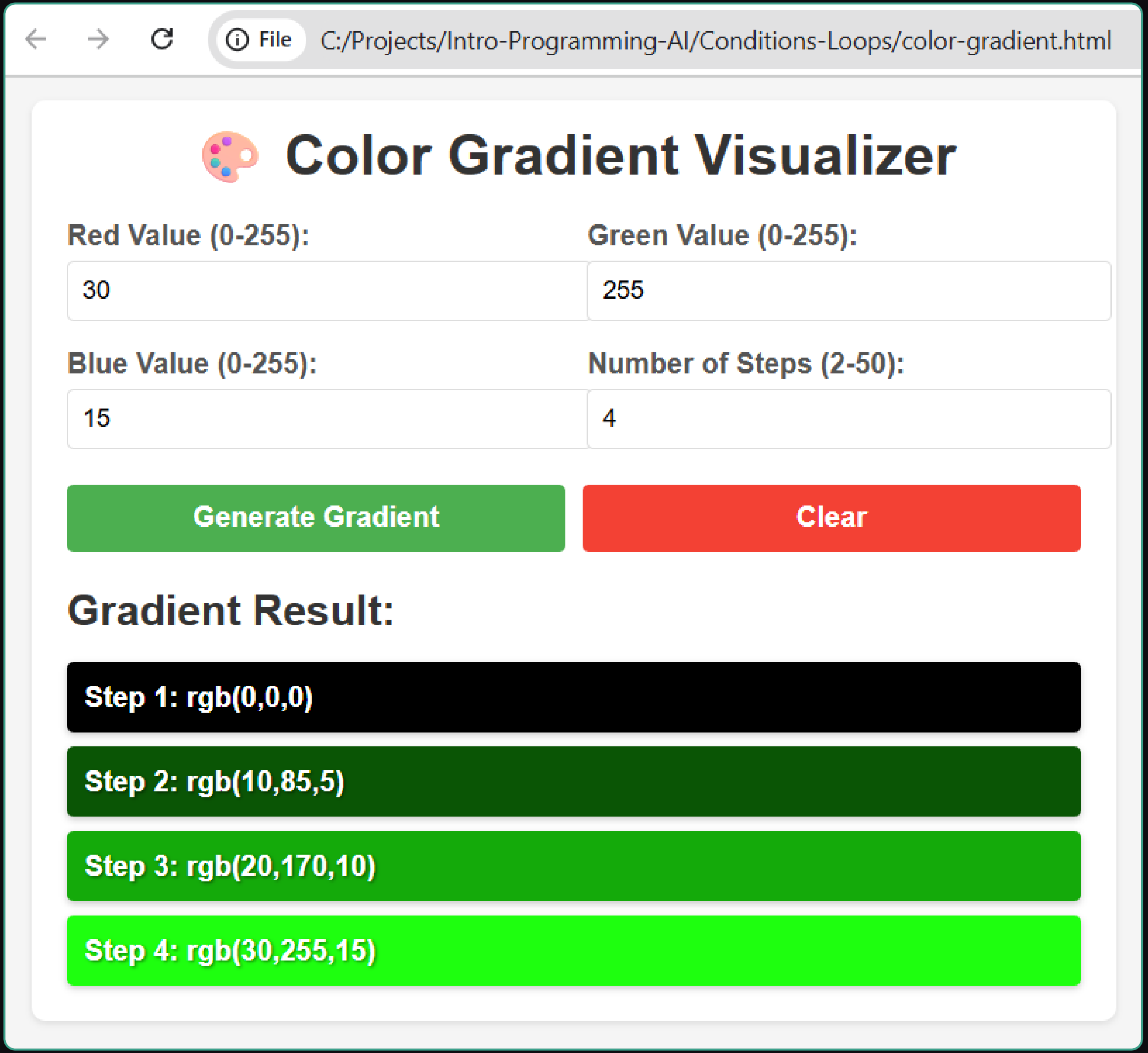
- In the AI era "***writing code***" is no longer a human activity
  - AI agents are **faster** (and **better** in most cases)
- **Reading** and **understanding** the code and **checking** if it works as intended, is still a **human activity**

Visualize the Gradient Loop as HTML

- Run a simple **prompt** in the GitHub Copilot agent:


color-gradient.js

Visualize the function `colorGradient(red, green, blue, n)` in HTML page: enter input data, invoke the function and display the returned results.


C:/Projects/Intro-Programming-AI/Conditions-Loops/color-gradient.html

Color Gradient Visualizer

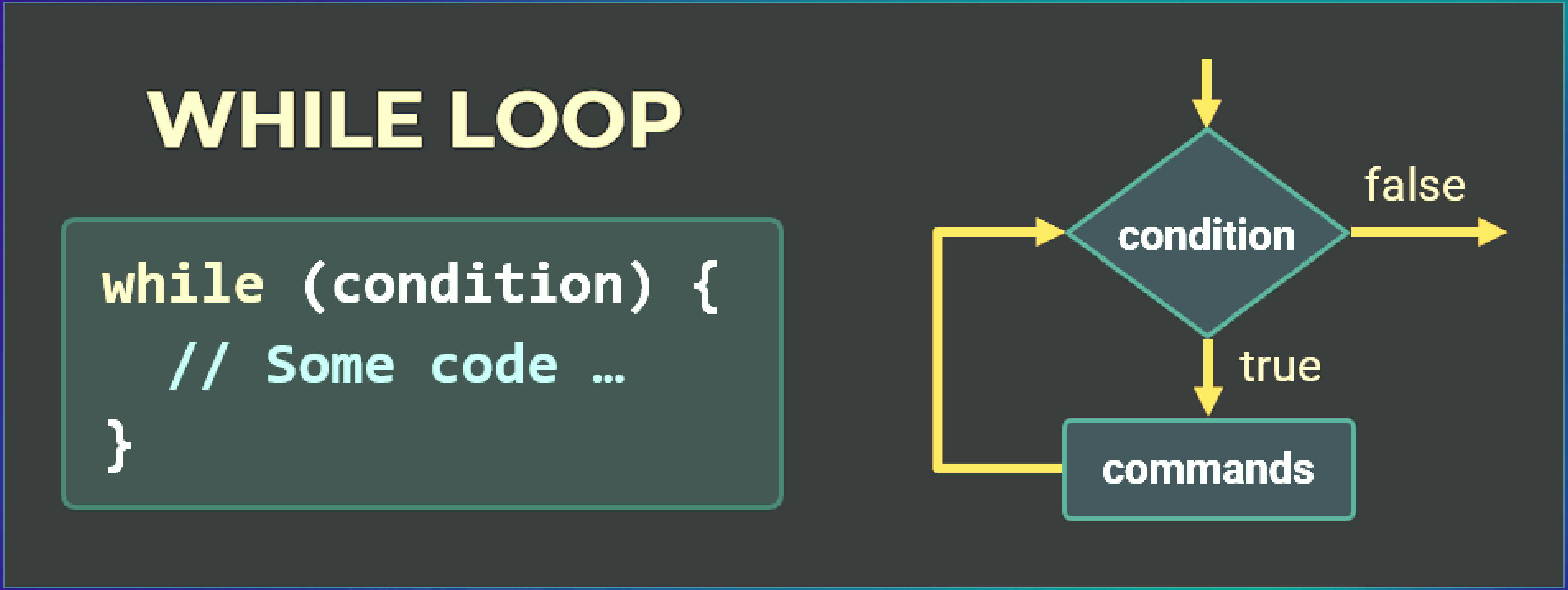
Red Value (0-255): 30
Green Value (0-255): 255
Blue Value (0-255): 15
Number of Steps (2-50): 4

Gradient Result:

```
Step 1: rgb(0,0,0)
Step 2: rgb(10,85,5)
Step 3: rgb(20,170,10)
Step 4: rgb(30,255,15)
```

While Loops

While a Condition Holds, Repeat the Loop Body



WHILE LOOP

```
while (condition) {
  // Some code …
}
```

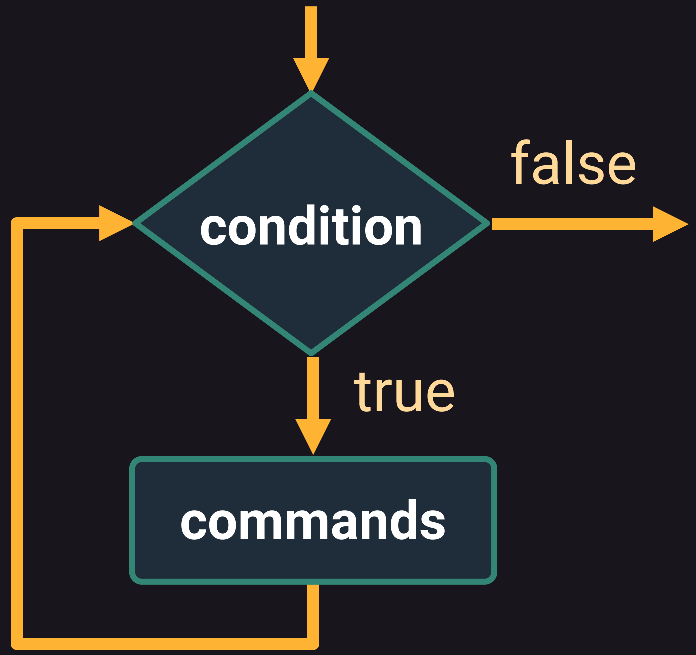
While Loop

- **While-loops** are simple:
  - While given **condition** holds true, **repeat** a block of code

```
while (condition) {
  // Some code …
}
```

- Example:

```
let num = 50;
while (num >= 1) {
  console.log(num);
  num = num / 2;
}
```



Problem: Sequence 2k+1

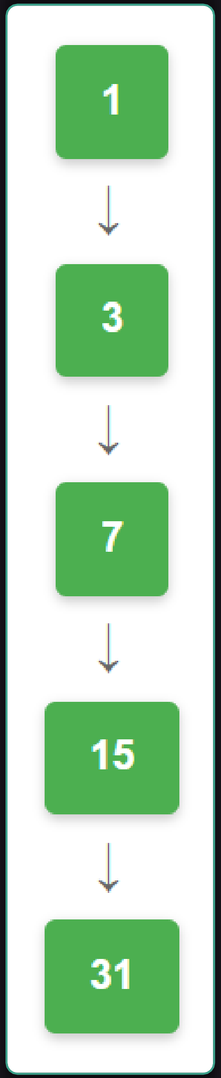
- We are given the sequence: **1**, **3**, **7**, **15**, **31**, …
  - **First** = **1**, each following = **2 * previous + 1**
- Write a function **seq2k1(n)** to return all sequence members **≤ n**, as comma separated string:

```
seq2k1(5)
1, 3
```

```
seq2k1(15)
1, 3, 7, 15
```

```
seq2k1(32)
1, 3, 7, 15, 31
```

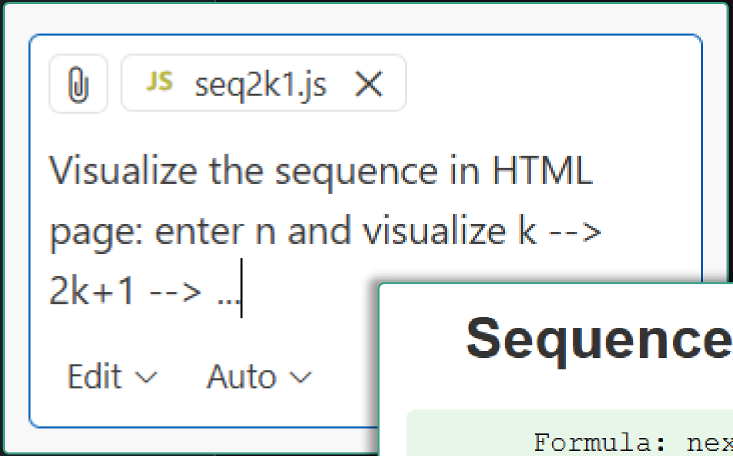
```
seq2k1(3000)
1, 3, 7, 15, 31, 63, 127, 255, 511, 1023, 2047
```



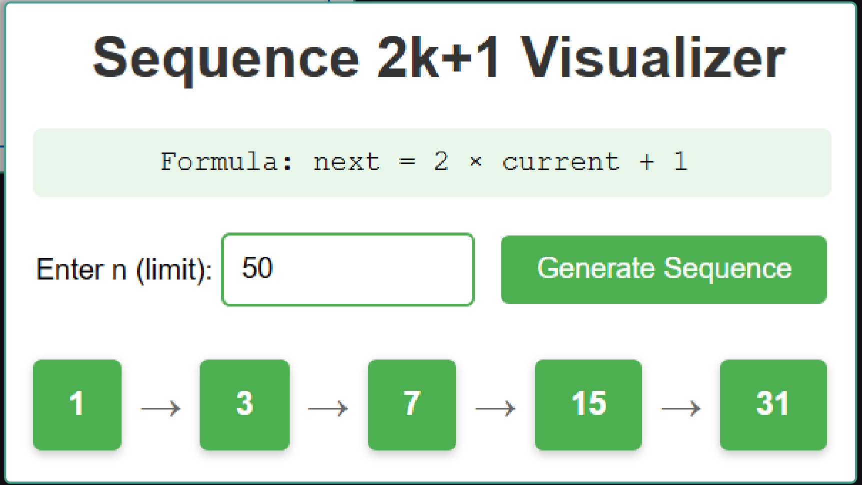
Solution: Sequence 2k+1

```
function seq2k1(n) {
  let seq = 1, output = "";

  while (seq <= n) {
    if (seq > 1)
      output += ", ";
    output += seq;
    seq = 2 * seq + 1;
  }

  return output;
}
```

- Let's **visualize** the sequence in HTML:


seq2k1.js

Visualize the sequence in HTML page: enter n and visualize k --> 2k+1 --> ...


Sequence 2k+1 Visualizer

```
Formula: next = 2 × current + 1
```

Enter n (limit): 50

1 → 3 → 7 → 15 → 31

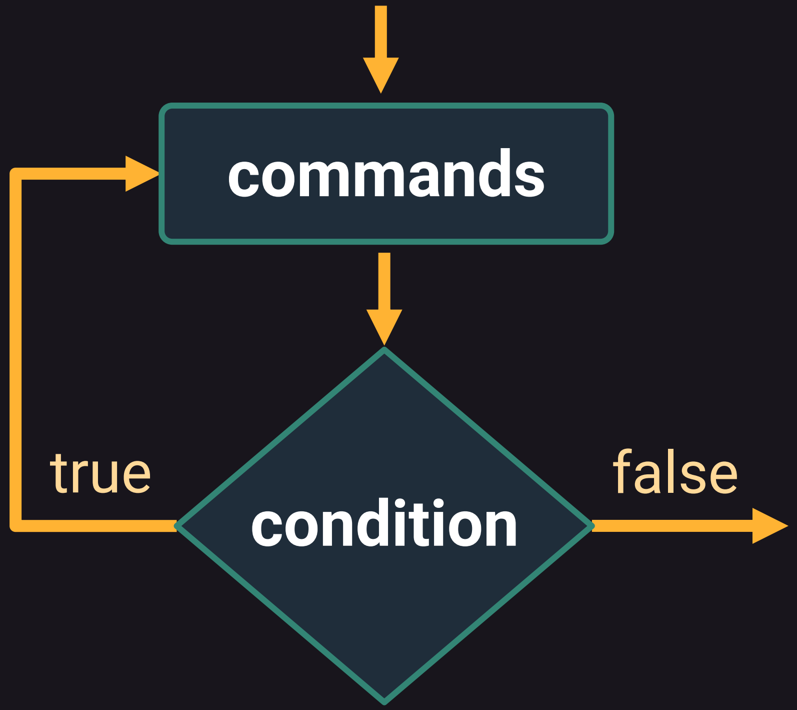
Judge link: https://alpha.judge.softuni.org/contests/control-flow-logic/5271

Do-While Loop

- **Do-while loops** are simple:
  - **Repeat** a block of code while an **exit condition** holds
- Example:

```
let num = 50;
do {
  console.log(num);
  num = num / 2;
} while (num >= 1);
```

```
do {
  // Some code …
} while (condition);
```



Infinite Loops

- **Infinite loops** are loops without an exit condition
  - In most cases are created **by mistake**
- Infinite loop without an exit:

```
let num = 0;
while (true) {
  console.log(++num);
}
```

```
let num = 0;
for (;;) {
  console.log(++num);
}
```

- Infinite loops may cause the app to "***hang***" (to make their **UI unresponsive**)

Infinite Loops with a break

- This loop looks like infinite, but exits after 3 seconds

```
let num = 0;
const startTime = Date.now();

while (true) {
  console.log(++num);
  if (Date.now() - startTime >= 3000)
    break;
}
```

Problem: Guess a Number

- Generate a **random secret number** in the range [1…10] and **interactively guess it**
  - User makes a guess
  - If the guess matches the secret, print "**Correct!**" and **exit**
  - Otherwise, print "**Higher**" or "**Lower**" and try another guess

```
Guess the number (1-10):
5
Higher
Guess the number (1-10):
8
Lower
Guess the number (1-10):
7
Correct!
```

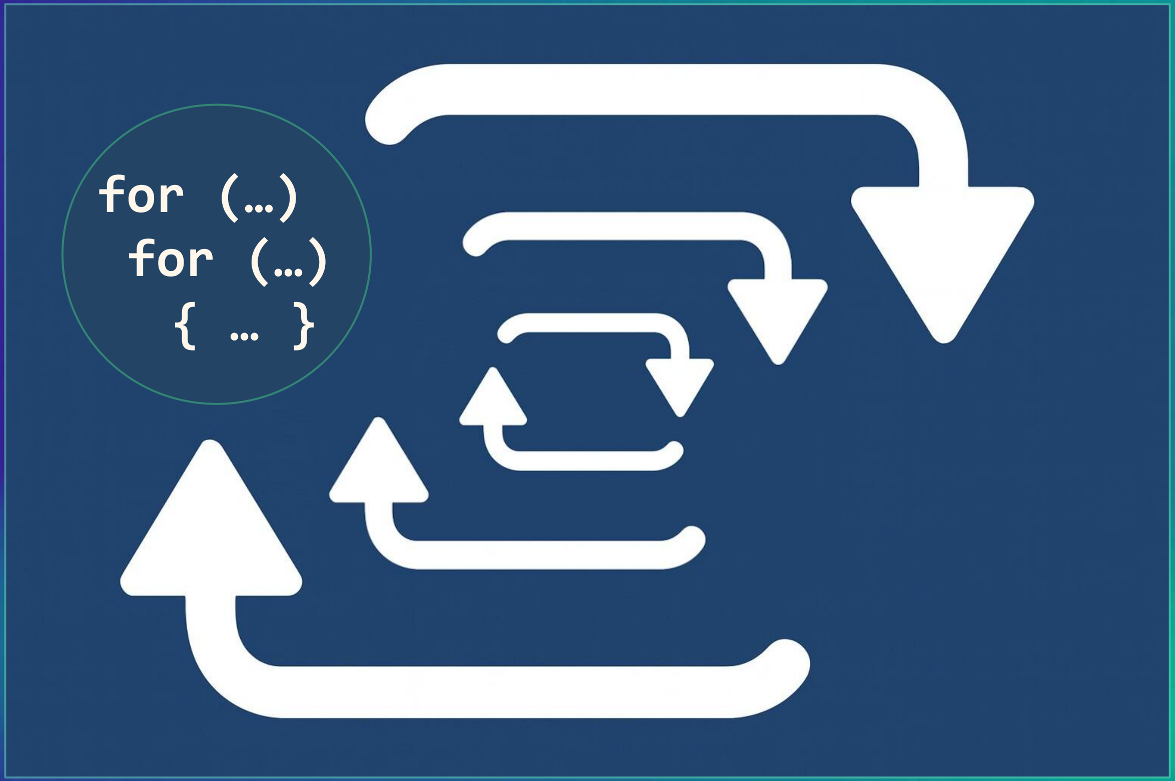
Solution: Guess a Number

```
const secret = Math.floor(
  Math.random() * 10) + 1;
while (true) {
  let guess = Number(prompt(
    "Guess the number (1-10):"));
  if (guess == secret) {
    alert("Correct!");
    break;
  }
  if (guess < secret)
    alert("Higher");
  else
    alert("Lower");
}
```

- **Important**: this code will run **in the browser only**!
  - **prompt()** and **alert()** are unavailable in Node.js
- **Math.random()** returns a random number [0…1)

Nested Loops

Loops inside Other Loops



```
for (…)
 for (…)
   { … }
```

Nested Loops

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```
for (…)
 for (…)
  { … }
```

- **Nested loop** == a loop inside another loop

```
for (let row = 1; row <= 5; row++) {
  let stars = "";
  for (let cols = 1; cols <= 10; cols++) {
    stars = stars + "*";
  }
  console.log(stars);
}
```

Outer loop

Inner loop

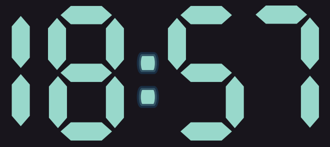
```
**********
**********
**********
**********
**********
```

- This will print a **10 x 5 rectangle of stars**

Example: Time from 0:00 to 23:59

- Print the time from **0:00**, **0:01**, **0:02**, … to **23:59**
  - Print the **hours** (0–23), and for each hour, print the **minutes** (0–59)

```
for (let h = 0; h <= 23; h++) // outer loop
  for (let m = 0; m <= 59; m++) // inner loop
    console.log(`${h}:${m < 10 ? '0' : ''}${m}`);
```



```
0:00    1:00    2:00          22:00    23:00
0:01    1:01    2:01          22:01    23:01
0:02    1:02    2:02    …     22:02    23:02
…       …       …             …        …
0:59    1:59    2:59          22:59    23:59
```

Problem: Time from 0:00 to 23:59

- Write a function to print the clock time
  - From **0:00**, **0:01**, **0:02**, … to **23:59**
- Solution: use **nested loops**
  - Outer loop: **0..23**, inner loop: **0..59**

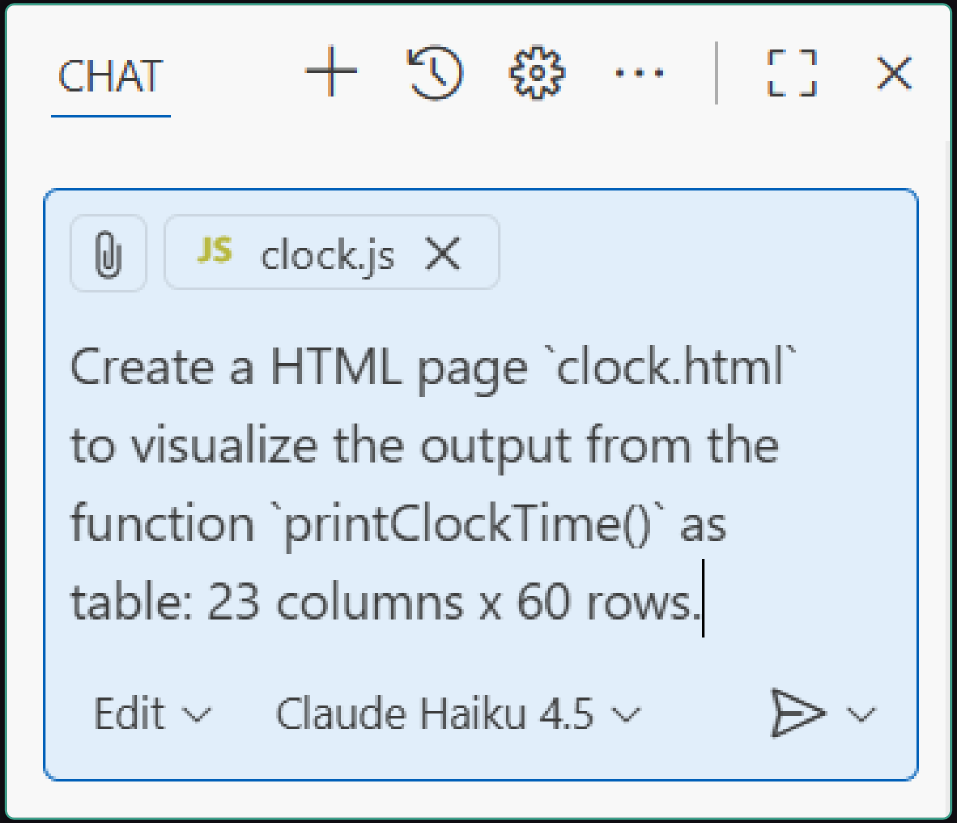
```
for (…)
 for (…)
   { … }
```

```
function printClockTime() {
  for (let h = 0; h <= 23; h++) // outer loop
    for (let m = 0; m <= 59; m++) // inner loop
      console.log(`${h}:${m < 10 ? '0' : ''}${m}`);
}
```

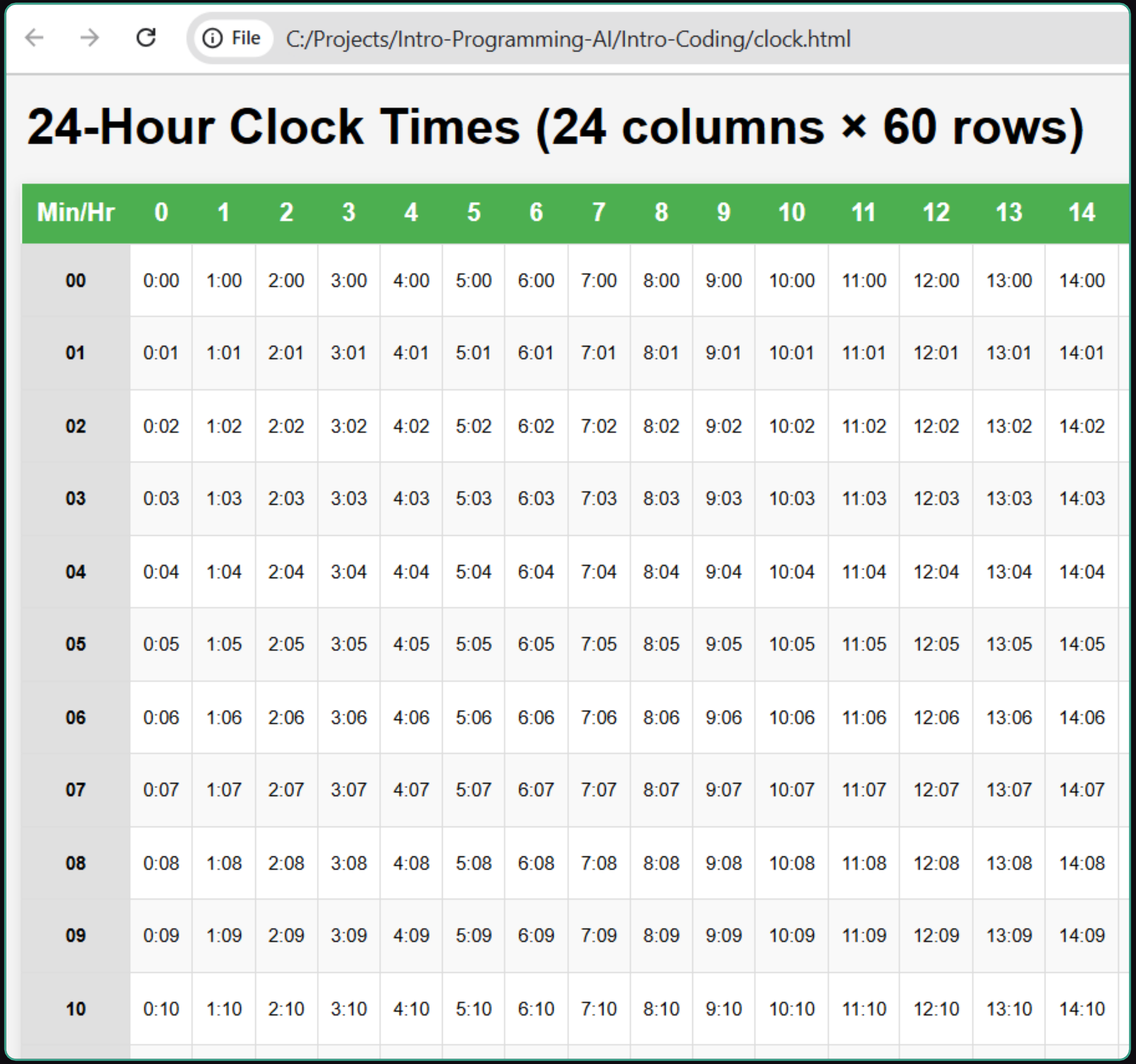
Judge link: https://alpha.judge.softuni.org/contests/control-flow-logic/5271

Visualize the Function with HTML

- Let's **visualize** the output from the function in HTML:



Create a HTML page `clock.html` to visualize the output from the function `printClockTime()` as table: 23 columns x 60 rows.


File C:/Projects/Intro-Programming-AI/Intro-Coding/clock.html

24-Hour Clock Times (24 columns × 60 rows)

Min/Hr	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
00	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00
01	0:01	1:01	2:01	3:01	4:01	5:01	6:01	7:01	8:01	9:01	10:01	11:01	12:01	13:01	14:01
02	0:02	1:02	2:02	3:02	4:02	5:02	6:02	7:02	8:02	9:02	10:02	11:02	12:02	13:02	14:02
03	0:03	1:03	2:03	3:03	4:03	5:03	6:03	7:03	8:03	9:03	10:03	11:03	12:03	13:03	14:03
04	0:04	1:04	2:04	3:04	4:04	5:04	6:04	7:04	8:04	9:04	10:04	11:04	12:04	13:04	14:04
05	0:05	1:05	2:05	3:05	4:05	5:05	6:05	7:05	8:05	9:05	10:05	11:05	12:05	13:05	14:05
06	0:06	1:06	2:06	3:06	4:06	5:06	6:06	7:06	8:06	9:06	10:06	11:06	12:06	13:06	14:06
07	0:07	1:07	2:07	3:07	4:07	5:07	6:07	7:07	8:07	9:07	10:07	11:07	12:07	13:07	14:07
08	0:08	1:08	2:08	3:08	4:08	5:08	6:08	7:08	8:08	9:08	10:08	11:08	12:08	13:08	14:08
09	0:09	1:09	2:09	3:09	4:09	5:09	6:09	7:09	8:09	9:09	10:09	11:09	12:09	13:09	14:09
10	0:10	1:10	2:10	3:10	4:10	5:10	6:10	7:10	8:10	9:10	10:10	11:10	12:10	13:10	14:10

Simple Multiplication Table

- Example: print the multiplication table in the format below

```
1 * 1 = 1
1 * 2 = 2
…
1 * 9 = 9
```

```
2 * 1 = 2
2 * 2 = 4
…
2 * 9 = 18
```

…

```
9 * 1 = 9
9 * 2 = 18
…
9 * 9 = 81
```

```
10 * 1 = 10
10 * 2 = 20
…
10 * 10 = 100
```

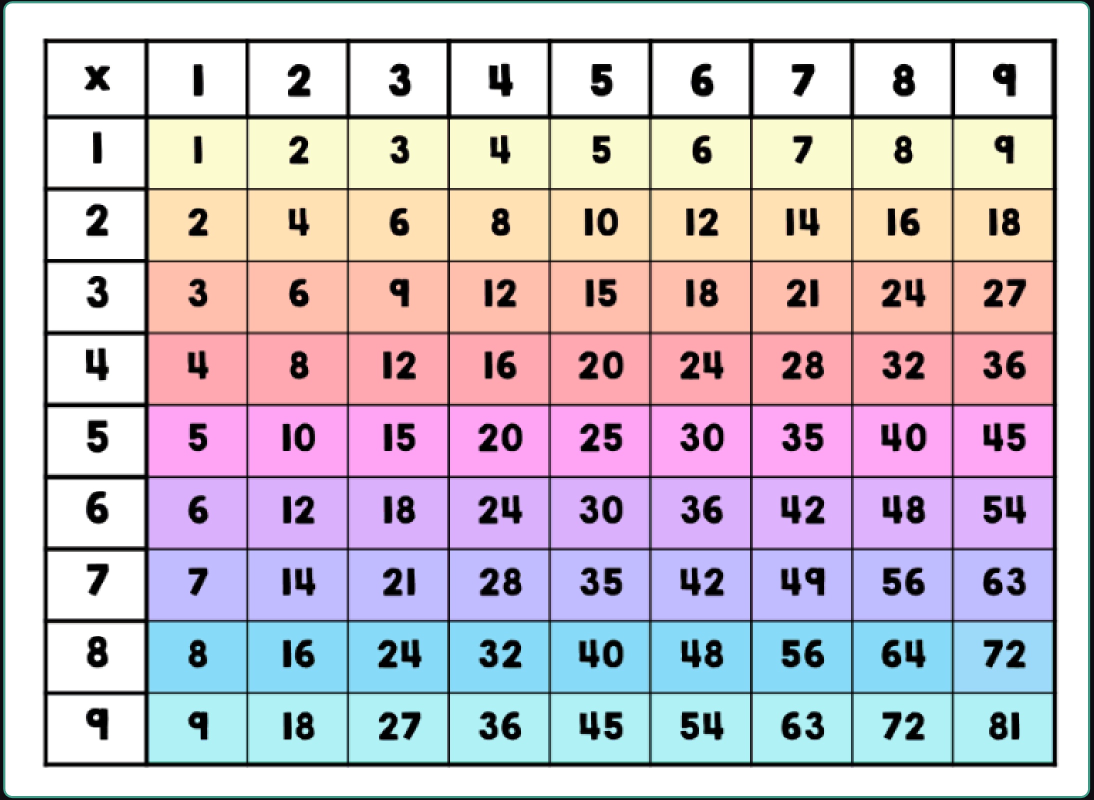
- Use a loop 1…10, holding inner loop 1..10:

```
for (let num1 = 1; num1 <= 10; num1++) // outer loop
  for (let num2 = 1; num2 <= 10; num2++) // nested loop
    console.log(`${num1} * ${num2} = ${num1 * num2}`);
```

Square Multiplication Table 9 x 9

- Now let's print a square multiplication table of size 9 x 9:

```
 x  |  1  2  3  4  5  6  7  8  9
--- |---------------------------
 1  |  1  2  3  4  5  6  7  8  9
 2  |  2  4  6  8 10 12 14 16 18
 3  |  2  4  6  8 10 12 14 16 18
 4  |  4  8 12 16 20 24 28 32 36
 5  |  5 10 15 20 25 30 35 40 45
 6  |  6 12 18 24 30 36 42 48 54
 7  |  7 14 21 28 35 42 49 56 63
 8  |  8 16 24 32 40 48 56 64 72
 9  |  9 18 27 36 45 54 63 72 81
```



x	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	4	6	8	10	12	14	16	18
3	3	6	9	12	15	18	21	24	27
4	4	8	12	16	20	24	28	32	36
5	5	10	15	20	25	30	35	40	45
6	6	12	18	24	30	36	42	48	54
7	7	14	21	28	35	42	49	56	63
8	8	16	24	32	40	48	56	64	72
9	9	18	27	36	45	54	63	72	81

Problem: Multiplication Table N x N

- Write a function to print a multiplication table of size **N** x **N**
  - Use appropriate **column size** to avoid overflow, but be consistent
  - This is how the table should look like:

```
x | 1 2 3
--|-------
1 | 1 2 3
2 | 2 4 6
3 | 2 4 6
```

n = 3, col width = 2,
first col width = 1

```
x |  1  2  3  4
--|-------------
1 |  1  2  3  4
2 |  2  4  6  8
3 |  2  4  6  8
4 |  4  8 12 16
```

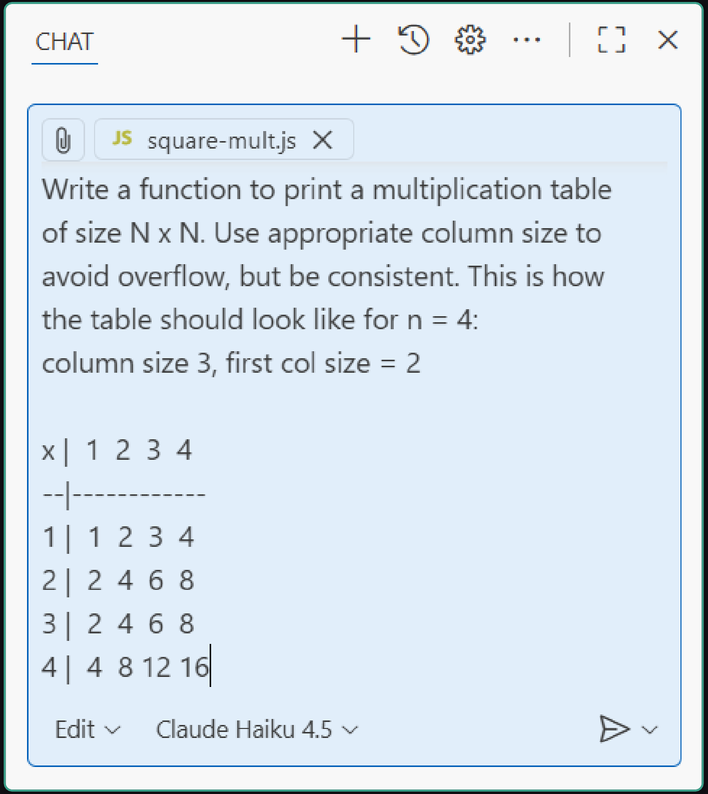
n = 4, col width = 3,
first col width = 1

n = 10, col width = 4,
first col width = 2

```
 x |   1   2   3   4   5   6   7   8   9  10
---|----------------------------------------
 1 |   1   2   3   4   5   6   7   8   9  10
 2 |   2   4   6   8  10  12  14  16  18  20
 3 |   2   4   6   8  10  12  14  16  18  30
 4 |   4   8  12  16  20  24  28  32  36  40
 5 |   5  10  15  20  25  30  35  40  45  50
 6 |   6  12  18  24  30  36  42  48  54  60
 7 |   7  14  21  28  35  42  49  56  63  70
 8 |   8  16  24  32  40  48  56  64  72  80
 9 |   9  18  27  36  45  54  63  72  81  90
10 |  10  20  30  40  50  60  70  80  90 100
```

Solution: Multiplication Table N x N

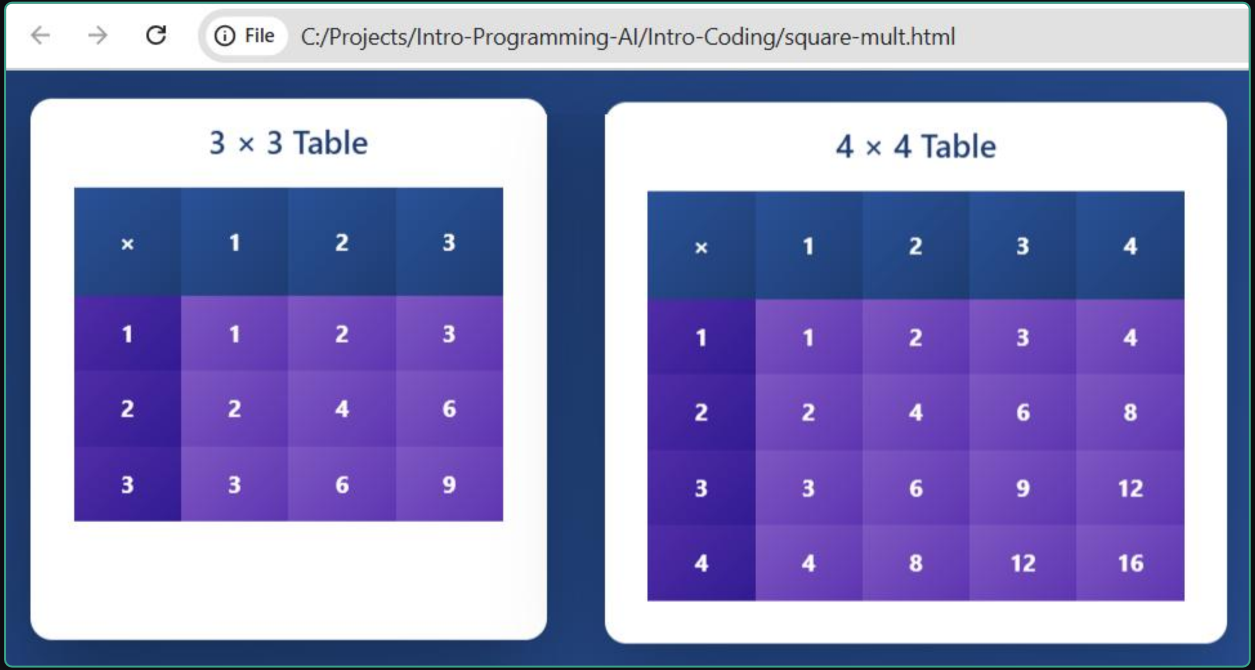
- For some people this could be **too complex** to write by hand, so we shall use a **Copilot prompt**:



Write a function to print a multiplication table of size N x N. Use appropriate column size to avoid overflow, but be consistent. This is how the table should look like for n = 4:
column size 3, first col size = 2

```
x|  1  2  3  4
--|------------
1|  1  2  3  4
2|  2  4  6  8
3|  2  4  6  8
4|  4  8 12 16
```

- Create a colorful HTML visualization


File C:/Projects/Intro-Programming-AI/Intro-Coding/square-mult.html

3 × 3 Table

×	1	2	3
1	1	2	3
2	2	4	6
3	3	6	9

4 × 4 Table

×	1	2	3	4
1	1	2	3	4
2	2	4	6	8
3	3	6	9	12
4	4	8	12	16

Judge link: https://alpha.judge.softuni.org/contests/control-flow-logic/5271

Problem: Triples

- Write a function **triples(n)** to print **all triples {a, b, c}** out of the numbers [**1…n**], in increasing order

```
triples(3)
1 2 3
```

```
triples(4)
1 2 3
1 2 4
1 3 4
2 3 4
```

```
triples(5)
1 2 3    1 4 5
1 2 4    2 3 4
1 2 5    2 3 5
1 3 4    2 4 5
1 3 5    3 4 5
```

Solution: Triples

- We can **nest loops several times**
- Example: triple nested loops

```
function triples(n) {
  for (let a = 1; a <= n; a++) // outer loop
    for (let b = a+1; b <= n; b++) // middle loop
      for (let c = b+1; c <= n; c++) // inner loop
        console.log(`${a} ${b} ${c}`);
}
```

Judge link: https://alpha.judge.softuni.org/contests/control-flow-logic/5271

Nested Loops with If-Else

Implementing More Complex Logic

Problem: Time Range

- Write a function to print the clock times in given **time range**
  - Use **nested loops** for the hours and minutes

```
timeRange(10, 58, 11, 2)
```

```
10:58
10:59
11:00
11:01
11:02
```

```
timeRange(7, 0, 7, 4)
```

```
7:00
7:01
7:02
7:03
7:04
```

Solution: Time Range (Wrong)

```
function timeRange(startHour, startMins, endHour, endMins) {
  for (let h = startHour; h <= endHour; h++) {
    for (let m = startMins; m <= endMins; m++) {
      console.log(`${h}:${m < 10 ? '0' : ''}${m}`);
    }
  }
}
```

- What will be the result of `printTimeRange(7, 55, 9, 15)`?

Judge link: https://alpha.judge.softuni.org/contests/control-flow-logic/5271

Solution: Time Range (Wrong Again)

```
function timeRange(startHour, startMins, endHour, endMins) {
  for (let h = startHour; h <= endHour; h++) {
    let currentStartMins = startMins;
    if (h > startHour) currentStartMins = 0;
    let currentEndMins = endMins;
    if (h < endHour) currentEndMins = 59;
    for (let m = currentStartMins; m <= currentEndMins; m++) {
      console.log(`${h}:${m < 10 ? '0' : ''}${m}`);
    }
  }
}
```

What will be the result of **printTimeRange(23, 58, 0, 2)**?

Judge link: https://alpha.judge.softuni.org/contests/control-flow-logic/5271

Solution: Time Range (Correct)

```
function timeRange(startHour, startMins, endHour, endMins) {
  if (startHour > endHour) endHour += 24;
  for (let h = startHour; h <= endHour; h++) {
    let currentStartMins = startMins;
    if (h > startHour) currentStartMins = 0;
    let currentEndMins = endMins;
    if (h < endHour) currentEndMins = 59;
    for (let m = currentStartMins; m <= currentEndMins; m++) {
      console.log(`${h % 24}:${m < 10 ? '0' : ''}${m}`);
    }
  }
}
```

Judge link: https://alpha.judge.softuni.org/contests/control-flow-logic/5271

Lesson Summary

- **If-else** statements implement conditional logic
  - Run different code blocks depending on input conditions
  - Conditions can be **complex**, if-else can be **nested**
  - Switch-case is like long if-else chain
- **Loops** repeat a block of code multiple times
  - Pass through ranges of values, e.g. **for i = 1 … 10**
  - Run some code **while** certain condition holds true
- **Nested loops** are loops inside other loops

Questions?

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